

TECHNICAL MANUAL

FUELS FOR USAF
PISTON AND TURBINE SUPPORT EQUIPMENT
AND
ADMINISTRATIVE VEHICLES

(ATOS)

F41608-80-D-A006

F41608-87-D-A288

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Dates of issue for original and changed pages are:

Original..... 0 17 May 2004 Change 1 30 June 2005

TOTAL NUMBER OF PAGES IN THIS MANUAL IS 16, CONSISTING OF THE FOLLOWING:

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INTRODUCTION

1. PURPOSE.

The purpose of this technical manual is to designate the grades of fuels to be used in all U.S. Air Force piston and turbine engine-powered support equipment and administrative vehicles. Equipment manuals should be consulted for additional information regarding specific fuel requirements and fuel substitutions. In the event of any conflicts between this manual and the equipment manuals, contact DET 3, WR-ALC/AFTT, 2430 C St, Bldg 70, Area B, Wright-Patterson AFB, OH 45433-7632, DSN 785-8050.

2. SCOPE.

This manual will reference the specifications used to identify the various types and grades of fuel. Acceptable fuel substitutions are presented as Alternate and Emergency fuel selections.

3. RESPONSIBILITIES.

- a. The Product Engineering Branch DET 3, WR-ALC/AFTT, is responsible for maintaining this document. Where provisions of this T.O. conflict with provisions contained in fuel and equipment manuals, the provisions in this T.O. will take precedence except as noted in this manual. Conditions or circumstances that prevent conformance to this technical order and cannot be resolved locally shall be reported. T.O. 00-5-1 outlines procedures for recommending changes to technical orders.
- b. Support Equipment (SE) – personnel in charge of operating/maintaining Support Equipment are responsible for determining that the correct fuel is

used and assuring that this fuel is serviced to the equipment. If the fuel used is other than the primary fuel, responsibility will extend to assuring that mechanical and operating adjustments are made as necessary in accordance with procedures prescribed in equipment manuals.

- c. Administrative Vehicles (AV) – personnel in charge of operating Administrative Vehicles are responsible for determining that the correct fuel is used and assuring that this fuel is serviced to the vehicle. If the fuel used is other than the primary fuel, responsibility will extend to assuring that mechanical and operating adjustments are made as necessary in accordance with procedures prescribed in equipment manuals.

4. DEFINITIONS.

- a. Primary Fuel – the fuel or fuels used during tests to demonstrate system performance (contract compliance).
- b. Alternate Fuel – a fuel that can be used in place of the primary fuel with a possible loss of efficiency. Engine adjustments may be necessary. The use of an alternate fuel may result in a change of maintenance or overhaul cost.
- c. Emergency Fuel – a fuel that can be used when the primary and alternate fuels are not available. This fuel is not for use on a continuing basis, but is to be employed only when the primary and/or alternate fuels are unobtainable and operation is mission essential.

CHAPTER 1

FUEL REQUIREMENTS

1.1 FUELS FOR PISTON-POWERED SUPPORT EQUIPMENT AND VEHICLES.

1.1.1 Spark-Ignition Engines. Fuels for equipment powered by spark-ignition engines are identified by the following specifications.

1.1.1.1 Leaded and Unleaded Motor Gasoline (MOGAS). Specification ASTM D4814 covers requirements for leaded and unleaded gasoline for use in all automotive vehicles and support equipment spark-ignition engines. The four grades are:

- a. Regular grade (product code MUR) will be used in all spark-ignition engines designated to operate on gasoline with this antiknock quality or when required by equipment manufacturer's recommendations. This grade may be required in 1971 or earlier model vehicles that have antiknock requirements which exceed those of special grade. Regular grades of gasoline have an ASTM Antiknock Index of 87.
- b. Midgrade (product code MUM) is an unleaded gasoline that satisfies vehicles with somewhat higher antiknock requirements than regular grade gasoline. Midgrade gasolines have an ASTM Antiknock Index of 89.
- c. Premium grade (product code MUP) is authorized only when recommended by the engine manufacturer or specified by this manual. Premium grades of gasoline have an ASTM Antiknock Index of 91.
- d. Leaded gasoline is intended for most vehicles that were designed to operate on leaded fuel. Leaded gasolines have an ASTM Antiknock Index of 88.

1.1.1.2 Aviation Gasoline. Two grades of commercial aviation gasoline are intended for use in aircraft reciprocating engines but may be used in support equipment powered by spark-ignition engines. These fuels are designed as ASTM D910, Grade 100 LL (blue) and Grade 100 (green) commercial aviation gasoline. These fuels are identical in antiknock quality but differ in maximum lead content and color. The color identifies the difference for those engines that have a low tolerance to lead.

1.1.1.3 Gasohol. Gasohol is a homogenous blend of 10% denatured anhydrous ethanol (from agricultural or forestry sources) and 90% unleaded gasoline. Gasohol is approved for use in commercial and administrative vehicles equipped with lower compression ratio spark-ignition

engines designed to operate on unleaded gasoline. Specification A-A-52530 outlines the uses of gasohol in specific motor vehicles.

1.1.2 Automotive Diesel and Compression-Ignition Engines. Fuels for equipment powered by automotive diesel and compression-ignition engines are identified by the following specifications.

1.1.2.1 Diesel Fuel. Specification A-A-52557 covers two grades of diesel fuel for use in automotive diesel and/or compression-ignition engines and gas turbine engines utilized in mobile electrical power generators. The two diesel fuel grades are low sulfur diesel fuel Grade 1 (DL1) and low sulfur diesel fuel Grade 2 (DL2). These fuels are acceptable under all climatic conditions. The temperature spans and other pertinent data for all three grades are provided in Table 1-1. Specification ASTM D975 covers the same grades of diesel fuel as A-A-52557. The two low sulfur diesel fuel grades covered by ASTM D975 are LS1 and LS2. The primary difference between both specifications is that A-A-52557 has a particulate content requirement (10 mg/L maximum when tested as per ASTM D6217) while ASTM D975 does not. The temperature spans and other pertinent data for diesel fuel are provided in Table 1-1.

1.1.2.2 Marine Diesel Fuel. Specification MIL-PRF-16884 (product code F76) pertains to one grade of marine diesel fuel. Fuel property requirements are provided in Table 1-3.

1.1.2.3 B20 Biodiesel Blend. B20 is a fuel blend consisting of 20 volume percent biodiesel and 80 volume percent diesel fuel (Grades DL1/DL2 or LS1/LS2) that can be used in lieu of diesel fuel in compression ignition engines. Specification A-A-59693 covers B20 requirements. B20 is allowed in meeting the requirements of the Energy Policy Act of 1992. One energy credit can be obtained by the use of 2,250 gallons of B20 in diesel vehicles weighing more than 8,500 pounds. B20 can also be used to meet the 20 volume percent petroleum fuels reduction requirement in Executive Order 13149 (Greening the Government through Federal Fleet and Transportation Efficiency). B20 properties are similar to those of Grade 2 diesel fuel (either DL1/DL2 or LS1/LS2). In cold weather, B20 can be purchased using the same 10th Percentile Minimum Temperature Figures in ASTM D975, Appendix X4. The following guidance is provided for areas/bases that use B20 or will be using B20 in the future.

- a. B20 may clean a vehicle/equipment fueling system of existing deposits. Vehicle/equipment maintenance should be prepared to change fuel filters

more frequently upon initial use (dependent on the condition of the vehicle/equipment fuel tank when the B20 was introduced). Vehicle/equipment fuel tanks should be inspected, drained, and/or cleaned as necessary prior to using B20.

- b. B20 in vehicles, equipment, and storage tanks must be used within six months from the delivery date to the installation. Vehicles and equipment that will not consume the complete B20 contents from individual vehicle tanks within six months from the delivery date shall either use a DL1/DL2 or LS1/LS2 diesel fuel instead. B20 shall not be provided for power production equipment since the six month product turnover period cannot be guaranteed.
- c. Whenever there is a suspected vehicle or equipment fuel tank contamination problem when using B20, a one-gallon sample from the vehicle or item of equipment and a one-gallon sample from the bottom of the service station tank where the vehicle received fuel, shall be forwarded to the Wright-Patterson Aerospace Fuels Laboratory immediately for analysis.

1.1.2.4 E85. E85 is a fuel blend nominally consisting of 70 to 85 volume percent denatured ethanol and the rest gasoline. As per Specification ASTM D5798, Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines, there are three E85 vapor pressure classes. The vapor pressure classes are, Class 1 (alcohol volume is 79 volume percent minimum), Class 2 (alcohol volume is 74 volume percent minimum), and Class 3

(alcohol volume is 70 volume percent minimum). The vapor pressure class of E85 fuel to be used depends upon geographical location and time of the year when the fuel is to be used. Refer to table in Appendix A of Handbook for Handling, Storing, and Dispensing E85 available from Energy Efficiency and Renewable Energy (EERE) website (<http://www.eere.energy.gov/>). The handbook summarizes each E85 class to be used per location and per month. E85 is considered an alternative fuel by the 1992 Energy Policy Act and can be used to meet the 20 volume percent petroleum fuels reduction requirement in Executive Order 13149. As E85 contains a very high volume of alcohol, it is **NOT RECOMMENDED FOR USE** in conventional gasoline spark-ignition engines, as there will be material compatibility problems with the alcohol. Instead, E85 can be used in flexible fuel vehicles that can use either E85 or gasoline as primary fuel. As for the E85 handling, it should be handled like gasoline and care must be taken to keep water out as E85 cannot tolerate more than 1 percent by volume of water before alcohol separation occurs. For any additional guidance, contact DET 3, WR-ALC/AFTH, Wright-Patterson AFB OH, DSN 785-8070.

1.1.2.5 Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG). CNG and LNG are alternative fuels that can only be used in natural gas vehicles and dual-fuel (gasoline and CNG/LNG) vehicles. See Specification ASTM D1835 (Standard Specification for Liquefied Petroleum (LP) Gases) for those products commonly referred to as liquefied petroleum gases. The four basic types of liquefied petroleum gases that are approved for use and the most common used applications are covered in the specification.

Table 1-1. Physical Characteristics of Diesel Fuel (ASTM D975 and A-A-52557)

PROPERTIES	REQUIREMENTS		
	GRADES DL1 AND LS1	GRADE 2	
		CONUS (GRADES DL2 AND LS2)	OCONUS (See ¹)
Cetane Number, (minimum)	40	40	47
Flash Point, °C (°F), minimum	38 (100)	52 (126)	56 (133)
Cloud Point, °C (°F), maximum	See ²	See ²	-10 (14)
Cold Filter Plugging Point (CFPP), °C (°F), maximum	N/A	N/A	-20 (-4)
Viscosity, mm ² /s at 40°C (104°F)	1.3 to 2.4	1.9 to 4.1	1.5 to 4
Sulfur, Mass Percent, maximum	0.05	0.05	0.050
Operating Temperature Range, °C	See ²	See ²	See ³
¹ NATO Code F-54 diesel fuel. ² As specified by Appendix X4 in ASTM D 975. ³ See Table 1-2 as recommendation for OCONUS 10th percentile minimum temperatures.			

1.2 FUELS FOR GAS TURBINE-POWERED SUPPORT EQUIPMENT.

1.2.1 Gas Turbine Engines. Fuels for equipment powered by gas turbine engines are identified by the following specifications.

1.2.1.1 Military Turbine Fuels. Two specifications cover the requirements for military turbine fuels.

- a. Specification MIL-DTL-5624 covers the requirements for two grades of turbine fuel. Grade JP-4 is

a low flash point, wide-cut type fuel. Grade JP-5 is a high flash point, kerosene-type fuel.

- b. Specification MIL-DTL-83133 covers the requirements for Grade JP-8, the primary fuel for most USAF turbine engine operated equipment and a kerosene fuel. The vapor pressure, viscosity, freezing point and flash point of JP-4, JP-5, and JP-8 are provided in Table 1-4.

Table 1-2. OCONUS 10th Percentile Minimum Temperatures, °C (°F)

Country	October	November	December	January	February	March	April
Austria	-1 (30)	-5 (23)	-12 (10)	-10 (14)	-9 (16)	-6 (21)	-1 (30)
Belgium	0 (32)	-3 (27)	-9 (16)	-7 (19)	-6 (21)	-6 (21)	-3 (27)
Denmark	-1 (30)	-3 (27)	-6 (21)	-7 (19)	-7 (19)	-7 (19)	-3 (27)
France	0 (32)	-2 (28)	-9 (16)	-9 (16)	-5 (23)	-5 (23)	-1 (30)
Germany	-2 (28)	-5 (23)	-13 (9)	-13 (9)	-12 (10)	-9 (16)	-5 (23)
Greece	5 (41)	0 (32)	-3 (27)	-3 (27)	-2 (28)	-1 (30)	3 (37)
Iceland	-1 (30)	-5 (23)	-7 (19)	-9 (16)	-7 (19)	-7 (19)	-4 (25)
Italy	1 (34)	-3 (23)	-6 (21)	-8 (18)	-7 (19)	-3 (27)	-1 (30)
Korea	1 (34)	-6 (21)	-13 (9)	-20 (-4)	-15 (5)	-7 (19)	-1 (30)
Luxembourg	1 (34)	-3 (27)	-7 (19)	-7 (19)	-6 (21)	-4 (25)	-2 (28)
Netherlands	0 (32)	-2 (28)	-8 (18)	-8 (18)	-6 (21)	-5 (23)	-2 (28)
Norway	-6 (21)	-14 (7)	-16 (3)	-18 (0)	-18 (0)	-16 (3)	-6 (21)
Portugal	8 (46)	4 (39)	1 (34)	1 (34)	1 (34)	1 (34)	5 (41)
Turkey	-1 (30)	-6 (21)	-10 (14)	-16 (3)	-16 (3)	-6 (21)	-1 (30)
United Kingdom	0 (32)	-4 (25)	-4 (25)	-4 (25)	-6 (21)	-4 (25)	-4 (25)

NOTE

This table is taken from canceled Specification VV-F-800E, dated 13 July 1994.

Table 1-3. Physical Properties of Marine Diesel Fuel, MIL-PRF-16884 (NATO/ASCC Symbol F-76)

Properties	Requirements
Cetane Number (MIN)	42
Cloud Point, °C (°F) (MAX)	-1.0 (30)
Pour Point, °C (°F) (MAX)	-6.0 (20)
Flash Point, °C (°F) (MIN)	60 (140)
Viscosity, mm ² /s at 40°C (104°F)	1.7 to 4.3
Sulfur, Mass Percent (MAX)	1.0

1.2.1.2 Commercial Turbine Fuels. Three types of commercial turbine fuels can serve as alternate fuels for military applications. Commercial fuels may not have the recommended fuel additives Fuel System Icing Inhibitor (FSII), Corrosion Inhibitor/Lubricity Improver (CI/LI) and Static Dissipator Additive (SDA).

- Types Jet A and Jet A-1 are kerosene fuels resembling JP-8 and can serve as an alternate fuel.
- Type Jet B is a mixture of gasoline and kerosene similar in many respects to JP-4 and may be employed as an emergency fuel for turbine

engines. Neither Jet B nor JP-4 are recommended for use in compression-ignition (diesel) engines as severe engine damage may occur.

NOTE

When using a fuel other than JP-8, it may be necessary to manually adjust fuel controls of turbine engines to avoid exceeding engine operating limits, particularly RPM and temperature.

Table 1-4. Physical Properties of Gas Turbine Engine Fuels

Property	MIL-DTL-5624		MIL-DTL-83133	ASTM D6615	ASTM D1655		ASTM D910
	JP-4	JP-5	JP-8	JET B	JET A-1	JET A	100/130
Specific Gravity, kg/L @ 15°C (59°F) (MIN)	0.751	0.788	0.775	0.751	0.775	0.775	—
Specific Gravity, kg/L @ 15°C (59°F) (MAX)	0.802	0.845	0.840	0.802	0.840	0.840	—
Specific Gravity, kg/L @ 15°C (59°F), typical ¹	0.769	0.817	0.805	0.769	0.805	0.817	0.703
Density, lb/gal (typical) ¹	6.4	6.8	6.7	6.4	6.7	6.8	6.0
Flash Point, °C (°F) (MIN)	-29 (-20) ²	60 (140)	38 (100)	-29 (-20) ²	38 (100)	38 (100)	-32 (-26) ²
Vapor Pressure, psi (range)	2.0 – 3.0	—	—	2.0 – 3.0	—	—	5.5 – 7.0
Freezing Point, °C (°F) (MAX)	-58 (-72)	-46 (-51)	-47 (-53)	-50 (-58)	-47 (-53)	-40 (-40)	-58 (-72)
Viscosity at -20°C (32°F), mm ² /s (MAX)	—	8.5	8.0	—	8.0	8.0	—
BTU/gal (MIN) ³	115,000	120,000	119,000	115,000	119,000	119,000	109,000 ⁴
BTU/lb (MIN)	18,400	18,300	18,400	18,400	18,400	18,400	18,700
Fuel System Icing Inhibitor, volume percent (range)	0.10 – 0.15	0.10 – 0.15	0.10 – 0.15	Optional for Commercial Fuels			Optional
Corrosion Inhibitor/Lubricity Improver (CI/LI)	Yes	Yes	Yes	Permitted by Agreement			Optional
Static Dissipator Additive, pS/m (range)	150 – 600	No	150 – 450	Generally Included Outside United States			No
Antioxidants, mg/L (range)	17.2 – 24	17.2 – 24	17.2 – 24	Optional			Yes
Metal Deactivator, mg/L (MAX)	5.7	5.7	5.7	Optional			No
¹ Typical average for fuels procured since 1970 in continental U.S.A. ² Typically measured values, no specification requirement stated. ³ Value based on minimum fuel specific gravity from specification and reported to three significant figures. ⁴ Value based on typical fuel specific gravity.							

CHAPTER 2

FUEL PREFERENCE

2.1 FUEL PREFERENCE.

The primary, alternate, and emergency fuels for spark-ignition, compression-ignition and gas turbine engines are designated in Table 2-1. The alternate or emergency fuels in a given category are listed in order of preference

indicated by alphabetical letters. Using DIESEL VEHICLES as an example, primary fuels are DIESEL and B20 with the order of preference being A (DFM), B (COMMERCIAL JET A, COMMERCIAL JET A-1, JP-5 OR JP-8), C (FUEL OIL 1 and 2), and D (JP-4 OR COMMERCIAL JET B blended as EMERGENCY ONLY).

Table 2-1. Fuel Preference

Fuel	Turbine Fuel Support Equipment	Diesel Support Equipment	Diesel Power Generation	Diesel Vehicles	MOGAS Vehicles	Unleaded MOGAS Vehicles	Heating Plant Boilers	Flexible Fuel Vehicles	Natural Gas Vehicles	Dual Fuel Vehicles
JP-4 or Commercial Jet B	Primary	D1, 2	D1, 2	D1, 2	—	—	—	—	—	—
JP-5	Primary	B ³	B ³	B	—	—	A ⁴	—	—	—
JP-8	Primary	B ³	B ³	B	—	—	A ⁴	—	—	—
AVGAS	Blended C1, 5	—	—	—	C (100/130) Blend ⁶	—	—	—	—	—
Leaded MOGAS	Blended C1, 5	—	—	—	Primary	—	—	—	—	—
Unleaded MOGAS	Blended B1, 5	—	—	—	A1, 7, 8	Primary	—	Primary	—	Primary
Fuel Oil Grades 1 and 2	—	C	C	C	—	—	Primary	—	—	—
Diesel Fuel Marine (DFM)	A1, 9	A	A	A	—	—	A ⁴	—	—	—
Commercial Jet A	Primary	B ³	B ³	B	—	—	A ⁴	—	—	—
Commercial Jet A-1	Primary	B ³	B ³	B	—	—	A ⁴	—	—	—
Diesel DL1 and LS1	A1, 9	Primary	Primary	Primary	—	—	A ⁴	—	—	—
Diesel DL2 and LS2	A1, 9	Primary	Primary	Primary	—	—	A ⁴	—	—	—
Gasohol	—	—	—	—	B (limited) ^{1, 7, 8}	Primary	—	—	—	—

Table 2-1. Fuel Preference - Continued

Fuel	Turbine Fuel Support Equip-ment	Diesel Support Equip-ment	Diesel Power Genera-tion	Diesel Vehicles	MOGAS Vehicles	Unleaded MOGAS Vehicles	Heating Plant Boilers	Flexible Fuel Vehicles	Natural Gas Vehicles	Dual Fuel Vehicles
B20	—	A	B ¹	A	—	—	B ¹	—	—	—
E85	—	—	—	—	—	—	—	Primary	—	—
Natural Gas (CNG, LNG)	—	—	—	—	—	—	—	—	Primary	Primary
<p>¹ Emergency only.</p> <p>² Blended with 50% Diesel (DF-2 only) by volume. Aviation Fuel Grade JP-4 (or Jet B) should be used only when no other fuels are available. JP-4 (or Jet B) and mixtures of JP-4 (or Jet B) and other fuels are dangerous due to the extremely low flash point of the JP-4 (or Jet B). When this fuel or fuel mixtures must be used in DAY TANKS or operating tanks located inside buildings or structures, every precaution must be taken to protect the product from any ignition source. Base Ground Safety Personnel must be consulted prior to implementing use of JP-4 in diesel engines. Tanks containing this mixture should be temporarily marked BLENDED FUEL IN USE — DANGER.</p> <p>³ Some units powered by diesel fuels are authorized to operate on JP-5/JP-8 as a primary or alternate fuel. Refer to the applicable equipment manual for instructions.</p> <p>⁴ Blending and burning alternate fuels with conventional boiler fuel must be coordinated with civil engineering at command level. For detailed engineering data on blending, contact AFCESA/CESM, 139 Barnes Drive, Suite 1, Tyndall AFB, FL 32403-5319; COMM: (850) 283-6222, DSN: 523-6222.</p> <p>⁵ Blended 50/50 with JP-4. Under no circumstances should this blend be premixed and stored. Equipment utilizing this blend should be tagged BLENDED FUEL IN USE.</p> <p>⁶ AVGAS (100/130 only) for use as MOGAS must be blended 50/50 with MOGAS. This mixture should be used only in extreme emergencies when no other type of MOGAS is available and requirement is mission essential.</p> <p>⁷ Fuels acceptable for use as an alternate fuel until the primary fuel is available, unless specifically denied by the applicable technical order.</p> <p>⁸ Extended use in vehicles not specifically designed for unleaded fuel will result in rapid valve wear. Consult applicable equipment technical order.</p> <p>⁹ Some mobile electric power units are authorized to operate on diesel fuels as an alternate fuel. Refer to the applicable equipment manual for clarification. Contact the applicable AFMC technical office if further clarification is required.</p>										

